

This invention relates to a system and method of co-operative networking.

5 In the present specification the term "mobile device" encompasses all mobile transceivers of data, for example but not exclusively personal digital assistants, mobile telephones and laptop computers. The terms "communication network" and "network" encompasses but are not restricted to computer and telephony networks wherein data is passed
10 over the network between entities connected to the network. "Data" is used to refer to any form of information carried over the network, for example, but not exclusively video, telephone audio or textual information.

One way which at least partially alleviates the problems is to form a wireless network using wide bandwidth short range (WBSR) wireless links such as Bluetooth or IEEE802.11 either via access points or via direct wireless links between mobile devices and allowing users of the mobile devices to manually select resources to be shared.

25 Current networking protocols allow devices connected to the network to advertise their presence within a network but do not allow the devices to advertise their available resources and develop a co-operative networking scheme involving the sharing of resources between devices within the WBSR network ranges.

It is an object of the present invention to provide a telecommunication method which, at least partly, ameliorates at least one of the above mentioned disadvantages/problems.

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It is another object of the present invention to provide a method of improving the performance of a network which, at least partly, ameliorates at least one of the above mentioned disadvantages/problems.

- 10 It is another object of the present invention to provide a networking system which, at least partly, ameliorates at least one of the above mentioned disadvantages/problems.

- 15 It is a further object of the present invention to provide a networking protocol which, at least partly, ameliorates at least one of the above mentioned disadvantages/problems.

According to one aspect of the present invention there is provided a telecommunication method comprising the steps of:

- 20 providing a network including at least two network elements;
broadcasting data over the network by a first network element
indicating the resources of the first network element available for
sharing within the data;
requesting the use of at least part of the available resources of the
25 first network element by a second network element;
executing of a task by co-operation of the first and second network
elements; and

releasing the resources of the first network element by the second network element upon completion of the task.

5 The method may include the step of the first and second network elements negotiating a cost for the resources. The cost may be in the form of a monetary value or central processor time or other resource of the second network element, for example memory, storage or connections.

10 The method may further include the step of providing the network in the form of a wide band short range (WBSR) wireless network, for example utilising HIPERLAN, Bluetooth or IEEE 802.11

15 The method may include the step of providing at least one of the network elements in the form of a mobile device, for example a personal digital assistant (PDA), a mobile telephone or a laptop computer.

20 The method may also include the step of providing geographically distributed wireless base stations. This allows mobile devices to remain part of an overall network. The network may be provided in the form of a piconet.

The method may also include the step of providing memory, or a connection or processing power or power source or a cheap connection as the resource to be shared.

According to another aspect of the present invention there is provided a method of improving the performance of a network comprising the steps of:

- 5 providing a first network element adapted to broadcast over a network data indicative of its resources;
- providing a second network element adapted to select which of the first network element's resources it requires;
- requesting said required resources by the second network element;
- sharing said required resources; and
- 10 use of said required resources by the second network element in concert with its own resources in the execution of a task.

It will be appreciated that by improving the performance of this network the performance of the network elements will also be improved.

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- According to a further aspect of the present invention there is provided a network comprising first and second network elements, the first network element having broadcast means adapted to broadcast data indicative of resources of the first network element available for sharing, the second
- 20 network element having communication means adapted to request at least some of said available resources, the first and second network elements being adapted to execute a task, co-operatively utilising said resources.

- The network may be a wireless network and may be a wide band short
- 25 range wireless network. The network may be a piconet. The network may use HIPERLAN, Bluetooth or IEEE 802.11. Alternatively the network may be a hardwired LAN or WAN.

The first and second network elements may be any respectively, of a PDA, a PC, a laptop computer, a mobile phone, a router, a server, a regenerative repeater, a multiplexer or a codec.

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The resource available for sharing may be memory, central processor time (for example to increase processing power and speed), network connections (for example in order to reduce download/upload times) or a connection to a public land mobile network (for example in order to obtain the cheapest connection).

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According to a still further aspect of the present invention there is provided a networked resource sharing protocol including:

- 15 a discovery phase;
- a negotiation phase; and
- a fulfilment phase.

The discovery phase may include a first network element broadcasting a notification of its shareable resources over a network.

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The negotiation phase may include a second network element requesting at least some of the shareable resources of a first network element. The negotiation phase may include an agreement of a cost for the use of the shareable resources of a first network element by a second network element.

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The fulfilment phase may include the co-operative execution of a task by first and second network elements. The fulfilment phase may include the execution of a task by a first network element and the passing of its results to a second network element. The fulfilment phase may include
 5 the termination of communication between first and second network elements.

DESCRIPTION OF THE ~~PREFERRED EMBODIMENTS~~

Ins Brief Description OF THE Drawings

10 **Figure 1** is a schematic representation of two devices communicating via a network in accordance with the present invention;

15 **Figure 2** is a diagram showing interactions of the basic process of the present invention; and

Figure 3 is a flow chart showing the steps of the method of the present invention.

Ins Detailed Description of the Drawing

20 **Figure 1** shows a co-operative networking system 10 employing a method of co-operative networking in accordance with the present invention. The networking system 10 comprises first and second computers 12, 14 (labelled respectively as Device A and Device B) and a network 16, for example a wireless network such as a piconet. Each of the computers 12,
 25 14 is linked to the network via respective wide bandwidth short range (WBSR) wireless links 18,20.

Although shown as computers it will be appreciated that the networked devices could be any suitable network element including PDA, mobile phone, router, server, repeater, multiplexer or codec.

- 5 There may be any number of devices joined to the network and the network need not be wireless but could be hardwired. Similarly, a group of devices having wireless communication therebetween may form a piconet using, for example, Bluetooth, IEEE802.11 or HIPERLAN.
- 10 Figure 2 is a simplified diagram for the steps of the resource protocol according to the present invention.

Network Device A broadcasts a message, possibly in the form of a data pocket, which includes information about what resources, (for example
15 memory, processor time and network connections), it has available to share with other networked devices (step 50). If a particular networked device or group of networked devices is/are targeted by Device A to share its resources with the message may not be broadcast but could be unicast or multicast.

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Network Device B assesses its own network capabilities and estimates a shortfall from the optimum requirements to execute its current tasks and requests that Device A supplies this shortfall. In the example of Figure 2 this shortfall is one connection and 20% of the processing power of
25 Device A. If Device A cannot match, or can only partly meet, the needs of Device B, Device B listens for broadcasts from other networked devices and can match resources from a combination of networked devices in order to meet its requirements.

In the example of Figure 2 Device A can meet the requirements of Device B and evaluates a cost for its shared resources. This costing of Device A's resources is sent to Device B (Step 54). The costing may be in
 5 monetary terms, deducted from the user account of Device B or may be in terms of a reciprocal resource sharing arrangement to be executed either concurrently or consecutively with the resource sharing of Figure 2.

Assuming that Device B agrees to the price set by Device A and
 10 communicates this to Device A along with notification that Device A has been assigned the task (Step 56), Device A can execute the task.

The task can be executed by Device A either in concert with Device B, a form of parallel processing, or in isolation from Device B, with the
 15 results of Device A's task being passed to Device B (Step 58). As shown in Figure 2 it is the latter of these two options which occurs in this example.

Device A then closes its communication channel with Device B (Step 60)
 20 and is free to re-advertise its available resources over the network for use by any networked device.

A network sharing protocol can be defined by the following division of the timing diagrams of Figure 2:

25 Discovery Phase - Step 50

Negotiation Phase - Steps 52, 54, 56

Fulfilment Phase - Steps 58, 60.

Figure 3 is a flow chart of a process according to the present invention.

Device A broadcasts a message containing information regarding its
 5 available shareable resources over a network, as do Devices C,D (Step
 70). A Device B assesses its needs for shared resources (Step 72) and
 assesses if Device A's shareable resources meet all of its requirements
 (Step 74). If not Device B may listen for broadcasts from other Devices
 and (Step 76) may elect to source all of its resource requirements from
 10 another Device or may source partial requirements from a number of
 Devices.

Device B requests part, or all, of Device A's shareable resources (step
 80). Device A sets a tariff for the use of its resources and sends this to
 15 Device B (Step 82). Device B either accepts or rejects this tariff (Step
 84).

If Device B rejects Device A's proposed tariff for its resources Device A
 reviews its tariff and decided whether to submit a new resource tariff
 20 (Steps 86 and 88). If Device A does not submit a new resource tariff the
 connection between Devices A and B is terminated (Step 90). Should
 Device A resubmit a revised tariff for its resources Device B must again
 decide whether to accept the tariff (Step 84).

25 Upon deciding to accept Device A's tariff Device B notifies Device A of
 this (Step 92) and Device A utilises its resources to execute the task it has
 been appointed by Device B. (Step 94). Device A then passes the results

of the task to Device B (Step 96) and the connection between Devices A and B is terminated (Step 98).

5 A method of sharing resources over a network according to the present invention allows devices to determine each other's capabilities (processing power, connections, memory and storage) and thereby offer new services by optimally using the power available with the network. These new services may include more rapid processing of information by parallel processing, an increase in the net memory and storage capacity of a
10 device by utilising memory and disk space of other devices and an increased bandwidth by a number of devices collectively downloading data.

15 An example of an application of such a method of network resource sharing include the collective downloading of a large data file, for example a video clip, by a number of devices. Each device may have only a slow cellular link, typically 9kbits⁻¹ for GSM and 30kbits⁻¹ for GPRS, to the download site. The combined download rate for a number of devices simultaneously downloading only a portion of the file will be
20 considerably higher than a single device attempting to download the whole file.

25 The combination of the processing power of a number of networked devices in a piconet or other network may allow them to carry out such complex tasks as predict the weather in their locale from information gathered by several spatially separated devices either on the ground or satellites.

A mobile telephone may use the resource sharing method of the present invention with other proximate mobile telephones and communicate call pricing information around the network. This would allow a mobile telephone user to "piggy back" their call onto another mobile telephone with spare call capacity and a cheaper call price and save money for the user.

In the case of piconets and similar wide bandwidth short range wireless networks it is possible that a mobile device, or series of mobile devices, may be used to relay a message beyond the broadcast range of the network transmitters.

A networked device transmits a message to a mobile device, advertising as having spare capacity to carry the message, which passes within the transmission range of the networked device, typically a few tens of metres.

The mobile device then passes out of the transmission range of the networked device. As the mobile device passes other mobile or networked devices it transmits the message to them. This continues until the desired host is reached and is in effect a flooding routing technique. In order to prevent networks becoming jammed with such messages a redundancy factor, for example, either a clock or a network hop counter, must be included so as to erase the message.

Advertisements can be disseminated by the use of the above-mentioned flooding routeing. This would be particularly useful, for example, in shopping malls where there is a high density of people many of whom will have mobile devices such as telephones or PDA's.

A further use of this method is in location awareness within a small-scale piconet. A non-location aware device could ascertain its position from a location aware device, for example one having GPS installed, to an accuracy of a few metres by requesting positional information as a resource.

The method of the present invention would find particular applicability in situations where there would be a low emphasis placed upon the "costing" of the shared resources, for example in a classroom teaching environment where resource cost is generally unimportant compared to the cost of machines themselves.